

WHAT IS CLAIMED IS:

5       1. A method of bit order synchronization during multiplexing and demultiplexing digital data, comprising:

          generating a serial data bit stream from a parallel data word by a serializer, the serial data bit stream including a marking pulse imposed upon a bit of the serial data bit stream; and

10           reconstructing the parallel data word from the serial data bit stream by a deserializer using the marking pulse.

15       2. The method of claim 1, wherein the marking pulse is imposed upon a specified bit in the serial data bit stream to mark the length of a serial data word corresponding to the parallel data word.

20       3. The method of claim 1, wherein the marking pulse is imposed upon a specified bit in the serial data bit stream to mark the position of a serial data word corresponding to the parallel data word.

25       4. A serializer for converting  $N$ -bit wide parallel input data words with rate  $B$  into a serial data bit stream with rate  $NB$  of out-going serial words, comprising:

30           a first multiplexer with ratio  $N:L$  for conversion of the  $N$ -bit wide parallel input data words with rate  $B$  into  $L$ -bit wide data words with rate  $NB/L$ ;

35           a converter for generating encoded data words from the  $L$ -bit wide data words;

a second multiplexer with ratio  $L:1$  for conversion  
of the encoded data words with rate  $NB/L$  into a serial  
5      data bit stream with rate  $NB$ ;

          a multilevel buffer for generating a multilevel  
output signal with marking pulses using the serial bit  
data stream and a synchronization signal; and

10      a timing circuit for generating the synchronization  
signal.

5.      The serializer of claim 4, wherein the timing circuit  
receives a frequency selection signal for selecting between a  
15      high frequency reference clock signal and a low frequency  
reference clock signal.

6. The serializer of claim 5, wherein the high frequency clock  
20      signal is an external reference clock signal.

7. The serializer of claim 5, wherein the low frequency clock  
signal is an external reference clock signal.

25      8. The serializer of claim 4, wherein the timing circuit  
generates a timing signal for the first multiplexer, the  
second multiplexer, the converter, and the multilevel buffer.

30      9.      The serializer of claim 4, wherein the multilevel buffer  
further comprises:

          a retiming sub-block for conversion of  $L$ -bit long  
synchronization pulses into 1-bit long retimed  
35      synchronization pulses; and

a     single-ended     current-switching     stage     for  
generating a multilevel serial data signal in which an  
5     amplitude of a bit coincident with a synchronization  
pulse and having a preselected logic value is increased.

10.   The serializer of claim 9, wherein the single-ended  
10   current-switching stage is for a preselected logic value of  
"1", the serializer further comprising:

          a first current source for generation of a first  
current;

          a second current source for generation of a second  
15   current with the same value as the first current;

          a first single-pole/single-throw switch coupled to  
the first current source and being closed by a direct  
input data signal;

20   a second single-pole/single-throw switch coupled to  
the second current source and being closed by an inverted  
input data signal;

          a third single-pole/single-throw switch coupled to  
the output of the first single-pole/single-throw switch  
25   and being closed by an inverted synchronization signal;

          a first resistor coupling the output of the third  
single-pole/single-throw switch with a positive power  
supply node; and

30   a second resistor coupling the output of the third  
single-pole/single-throw switch with the output of the  
second single-pole/single-throw switch serving as the  
stage output.

11.        The serializer of claim 4, wherein the multilevel buffer further comprises:

5            a retiming sub-block for generating 1-bit long retimed synchronization pulses using *L*-bit long synchronization pulses and for retiming and delay of the incoming serial data bit stream; and

10           a differential current-switching stage for generating direct and inverted two logic level serial data signals wherein the amplitude of a bit coincident with the synchronization pulse and having a preselected logic value is increased to a third logic level.

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12. The serializer of claim 11, wherein the differential current-switching stage for a preselected logic value of "1" further comprises:

20           a first current source for generation of a first current;

            a second current source for generation of a second current with the same value as the first current;

25           a first single-pole/double-throw switch with its input coupled to the first current source and shorted to its first output by a direct input data signal;

            a second single-pole/double-throw switch with its input coupled to the second current source and shorted to its first output by an inverted input data signal;

30           a first single-pole/single-throw switch coupled to the first output of the first single-pole/double-throw switch and being closed by an inverted synchronization signal;

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a second single-pole/single-throw switch coupled to the second output of the first single-pole/double-throw switch and being closed by an inverted synchronization signal;

a first resistor coupling an output of the first single-pole/single-throw switch to a positive power supply node;

a second resistor coupling the output of the first single-pole/single-throw switch with the first output of the second single-pole/double-throw switch serving as the stage direct output;

a third resistor coupling the output of the second single-pole/single-throw switch with the same positive power supply node; and

a fourth resistor connecting the output of the second single-pole/single-throw switch with the second output of the second single-pole/double-throw switch serving as the stage inverted output.

13. A deserializer circuit for generating  $N$ -bit wide parallel data words with rate  $B$  and a predetermined bit order from an incoming serial data bit stream with rate  $NB$ , comprising:

a timing circuit for generating timing signals using marking pulses imposed onto the incoming serial data stream, and for generating a serial data stream with rate  $NB$ ;

a first demultiplexer with ratio  $1:L$  for generating  $L$ -bit wide data words with rate  $NB/L$  using the serial data stream;

a data digital converter for generating decoded data words using the  $L$ -bit wide data words; and

a second demultiplexer with ratio  $L:N$  for converting the decoded data words into  $N$ -bit wide parallel data words with rate  $B$  and a bit order predetermined by the alignment of the timing signals to the marking pulses.

14. The deserializer circuit of claim 13, wherein the timing circuit further comprises:

a single-ended input detector for accepting the incoming serial data bit stream and retrieving data bits and synchronization pulses corresponding to the marking pulses, comprising:

a single-ended input buffer for impedance matching;

a single-ended pick sensor for detecting a maximum voltage level and a minimum voltage level of the input signal;

a voltage divider for generating a first threshold voltage and a second threshold voltage using the detected voltage levels;

a first comparator for retrieving synchronization pulse values in reference to the first threshold voltage; and

a second comparator for retrieving data bit values in reference to the second threshold voltage.

15. The deserializer circuit of claim 13, wherein the timing circuit further comprises:

a single-ended input detector for accepting the  
incoming serial data bit stream and retrieving data bits  
5        and synchronization pulses corresponding to the marking  
pulses, comprising:

          a single-ended input buffer for impedance  
matching;

10        a first comparator for retrieving  
synchronization pulse values in reference to a first  
external threshold voltage; and

          a second comparator for retrieving data bit  
values in reference to a second external threshold  
15        voltage.

16.        The deserializer circuit of claim 13, wherein the  
timing circuit further comprises:

20        a differential input detector for accepting incoming  
direct and inverted serial data bit streams with imposed  
marking pulses and retrieving data bits and  
synchronization pulses corresponding to the marking  
pulses, comprising:

25        a differential input buffer for impedance  
matching;

          a differential pick sensor for detecting a  
maximum voltage level and a minimum voltage level of  
30        the input signal;

          a voltage divider for generating a first  
threshold voltage using the detected voltage levels;

          a differential comparator for retrieving  
synchronization pulse values from both direct and  
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inverted input bit streams in reference to the first  
          threshold voltage; and

5           a limiting amplifier with two standard output  
          voltage levels for reconstruction of data bit  
          values.

10       17.     The deserializer circuit of claim 13, wherein the  
          timing circuit further comprises:

          a differential input detector for accepting incoming  
          direct and inverted serial data bit streams with imposed  
          marking pulses and retrieving data bits and  
15           synchronization pulses corresponding to the marking  
          pulses, comprising:

          a differential input buffer for impedance  
          matching;

20           a differential comparator for retrieving  
          synchronization pulse values from both direct and  
          inverted input bit streams in reference to an  
          external threshold voltage; and

25           a limiting amplifier with two standard output  
          voltage levels for reconstruction of data bit  
          values.